COMPUTERIZATION AND COMPETITIVENESS: NATIONAL INFORMATION INFRASTRUCTURE IN THE USA

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INTRODUCTION

The production and use of information technology (IT) is increasingly recognized by national governments as critically affecting the competitiveness of business and industry and the future quality of life for citizens. If a nation sits by and does nothing, it will not be left out, but it might be left behind. It will not be left out because information technology is spreading globally. IT is already widely diffused in developed countries and in many newly industrialized countries as well. And many developing countries are playing catch-up by making significant increases in spending for IT in the hopes of not being left behind in the struggle for competitive advantage. As a result, there is deepening concern about national policies for promoting production and use, and the effectiveness of those policies (Flamm, 1990; Kraemer and Dedrick, 1994a and b; Schware, 1992).

The policy choices are frequently viewed as bimodal, favoring production or use, rather than viewed as interrelated and mutually reinforcing. In fact, most countries want a mix of both. The NII experience in the United States illustrates how policies which are primarily use-oriented, are interrelated with and beneficial for IT production.

The NII stands for National Information Infrastructure, but is also referred to as the information superhighway, electronic superhighway or the infobahn. The NII is a very significant development in the United States for several reasons. First, it represents the first time that a U.S. president and vice president have come out with an explicit policy towards information technology (IT) production and use (Gore, 1993; IITF, 1993). In the past, policy has been implicit and part of other national goals such as national defense. Second, the NII is a national goal in its own right but also part of a new industrial policy aimed at global competitiveness (Council on Competitiveness, 1993). Such policy, which was anathema to the two previous administrations, is now a key plank in economic policy. Third, the Administration's proposals for NII have generated tremendous support among government, industry, education and the general public while generating fear abroad—particularly in Japan (TCOJ, 1994) and Europe (*The Economist*, 1994).

In the U.S., the NII is expected to generate considerable government and private investment in building, upgrading, and expanding computer and communications networks, facilities and services. Over the next 20-50 years, the federal government is expected to invest $40-100 billion and private industry $1-2 trillion, or about ten times the government investment (estimates from IITF, 1993 and SIM International, 1994). Government investments will be for R&D,

demonstration, industry regulation, NII promotion, intergovernmental networks and government information and services. Industry investments will be spent to rewire the country with fiber optic cable, increase the capacity of existing coaxial and copper cable, upgrade switching equipment, and install new equipment to provide new services, databases, information services and entertainment.

This paper provides a perspective on the NII in the United States and what it means for national competitiveness. It covers four major topics: (1) forces of technology, (2) convergence of processing and communications, (3) national information infrastructure, and (4) implications of NII for national competitiveness. Finally, it summarizes the main points and ends with a caveat about the impacts of the NII.

FORCES OF TECHNOLOGY

Processing Technology

The forces of technology shaping the NII are basically two: processing technology and communications technology. The basic processing technology is expected to show the same improvement in the next twenty years that it has shown in the past twenty years—around 20% improvement in performance annually. Human-computer interfaces will be easier to use, enable data, voice and video processing, and provide more functionality through software. Storage will be larger capacity, smaller size and much less expensive. By the year 2000, it is expected that there will be workstations capable of speeds of one billion instructions per second, having 100 megabytes of main memory and a terrabyte of disk storage, exhibiting display quality of HDTV, and producing Kodachrome quality printing (2400 dots per inch). In short, capabilities will be orders of magnitude greater and will cost no more than today's PCs. An important consequence of these developments is that there will be greater distribution of IT in business and society. There are currently about 100 million PCs in U.S. businesses, governments and households, and about 50% of these are connected to local networks, and to networks outside these venues. It is estimated that there will be one computer for every household and worker by the year 2015 and that most of these will be connected to one or more networks.

Communication Technology

A complete picture of information technology requires looking at communications as well as the processing technologies. The change here is equally dramatic. The U.S. is increasing the capacity of its computer, telephone and cable networks by replacing them with fiber optic cable while at the same time improving the capacity of existing copper and coaxial networks. Compression technologies will allow high speed data and video to be sent over existing twisted pair copper wires. Voice over coaxial cable technologies will allow voice to be sent over cable TV lines. Communications is also going multimodal just as processing is going multimedia. At the same time that land lines are being extended and upgraded, there is also tremendous growth in deployment of alternatives to land lines—namely, satellite and cellular communications. For example, cellular has already penetrated 3% of the U.S. population; a rate exceeded only in

Sweden (6%) and Hong Kong (3.15%), both of which are small countries (Davidson, et al., 1993).

The implications of these changes are illustrated by the prediction of Nicholas Negroponte, who is Director of MIT's Media Lab, and said that "whatever comes now by wire will come by air and that whatever comes now by air will come by wire." This prediction is already coming true. Telephone service was provided almost exclusively by wire in the U.S., but now is coming by air with cellular and satellites. Similarly, radio and television used to come almost exclusively by air, but now come by cable into 80% of U.S. homes.

CONVERGENCE OF PROCESSING AND COMMUNICATIONS

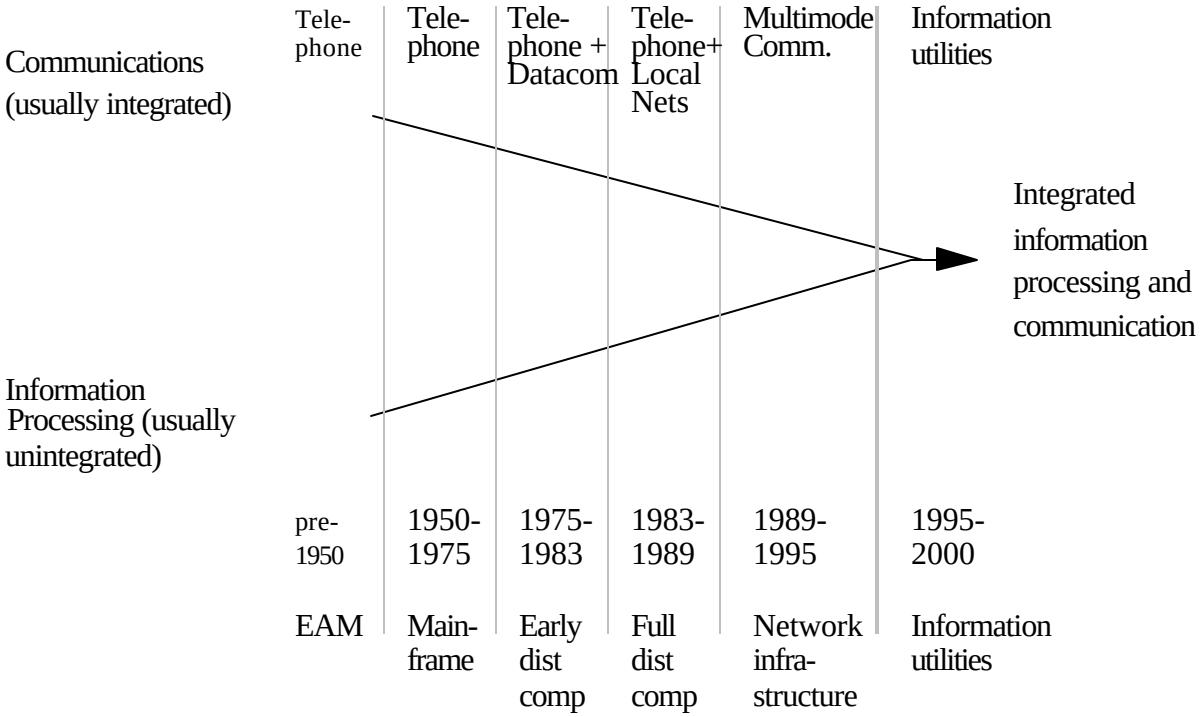
Important though these foregoing changes might be, they pale in comparison to the significance of their convergence. Processing and communications technologies are converging in unprecedented ways and this convergence is what gives rise to the NII more than any other single factor. Historically, processing and communications technology have been separated from one another—physically, institutionally and in terms of organizational arrangements for implementing and managing them. Each has had its own logic as shown in Figure 1. Starting at the bottom left, with electronic accounting machines (EAM), processing was historically distributed within organizations in order to be close to use and users. This trend has continued with the introduction of minicomputers in the mid-seventies and accelerated with the introduction of PCs in the mid-eighties.

Communications technologies have historically been integrated because it does not make much sense for them not to be connected. However, they have only been integrated within each mode—computer, telephone, and cable. It is only now that there is beginning to be a dramatic convergence among these three modes and the newer modes of cellular and satellite communications. The great convergence then is threefold: processing modes are being integrated at the workstation, communications networks are being integrated into a seamless "network of networks," and processing and communications technologies are being integrated with one another. These three streams have been converging over the last decade or longer. Within organizations, processing technologies have been integrated through local area networks of PCs and backbones linking these with file servers (mainframe computers, minicomputers) and other networks. They have been integrated to outside networks through gateways that connect the organizational backbones to telecommunications networks that are regional, national and global in nature. This convergence is not expected to be complete until well into the next century.

The convergence of processing and communications technologies is creating information utilities, which provide information services and large amounts of information to individuals and organizations through networks. Some information utilities provide vertical services targeted to industries like law, health, education, finance or trade (e.g., Lexis/Nexis legal data, TRW credit data, or Reuters brokerage data). Others provide horizontal services like electronic mail, news

groups and bulletin boards targeted to individuals (e.g., Prodigy, CompuServe and On-Line America).

Figure 1. Convergence of Processing and Communications

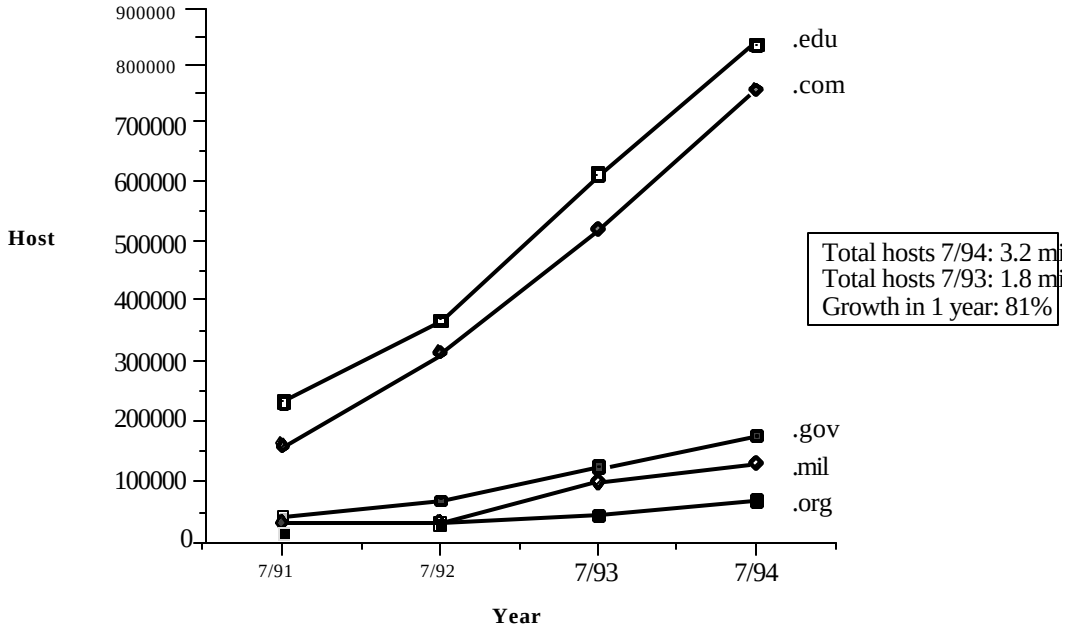


The Internet

One of the most interesting illustrations of the convergence of processing and communications is the Internet. The roots of the Internet go back to 1969 and the start of a DOD project called ARPANET, which was intended by the founders as a means of sharing computer resources between large computing centers. The first node, as network sites are called, was at UCLA and it linked with Stanford, UC Berkeley and the University of Utah. What made the linkage possible was a new hardware and software device called an Interface Message Processor (IMP) which routed data between sites, making sure the information got to the right destination. Initially, the scientists on the NET were other ARPA grantees who had to be coerced by their fundor to join the ARPANET. However, soon the NET's use spread throughout the computer science community, and later far beyond. By 1971, there were nearly two dozen sites, by 1974, there were 62, and by 1981, there were more than 200. It now became apparent that the significance of the NET was less its capability for sharing computer resources than for the new communities of scientists that it created. Although separated by geography, they were united by technology through applications such as electronic mail, file transfers, news groups, and bulletin boards. By the early seventies, other countries wanted to join in. This required an agreed upon set of technical standards, or protocols, that multiple networks could use. These

protocols paved the way for the Internet which now extends around the globe (*Newsweek*, August 8, 1994).[1]

Figure 2. Growth of the Internet in the U.S., 1991-1994



Source: Internet Domain Survey

The growth of the Internet has been phenomenal in recent years. Figure 2 shows (in the box) that the number of nodes (now called IP Hosts) grew by 81% worldwide between 1993 and 1994. The figure also shows the growth in nodes for five user domains within the U.S. from 1991-1994: organizations, military, government, commerce and education. Growth in all five domains has been considerable, but the growth in the education and commerce domains is extraordinary. Growth of the educational domain is not surprising because this is where the Internet all began. What is interesting, however, is that the slope of the growth curve for education was low before 1992, as can be seen by projecting the tail of the curve backwards twenty years to the 12 nodes that existed in 1971.

The greatest growth is in the commercial domain which basically started its use of the Internet in 1990. It is very likely that growth of the commercial domain will exceed education in the future. The education domain will continue to grow as use extends beyond the research universities to

[1]ARPANET went out of commission in 1990 as NSFNET, the new technical backbone for the Internet within the U.S., replaced it.

teaching institutions at the college, junior college and high school levels, but it will pale in comparison to the commercial domain because the number of firms that can be connected is enormous. Industry usually starts with its research workers, then extends use to marketing and sales, and often to all workers with a PC. Some companies, such as Hewlett-Packard and Sun Microsystems, have already put all of their workers on the Internet. Indeed, the new corporate status symbol is no longer the "25 year" logo, but the Internet address. It indicates one is a member of the cyberspace elite. Even Vice President Gore and President Clinton are on the Internet (president@whitehouse.gov and vice-president@whitehouse.gov).

None of these figures say anything about the number of users or usage. Overall, the number of Internet users is estimated to be 20 million within the U.S. and 10 million worldwide, growing at a rate of 40,000 users per month. Use of the Internet is primarily for electronic mail, file transfers, bulletin boards and newsgroups.

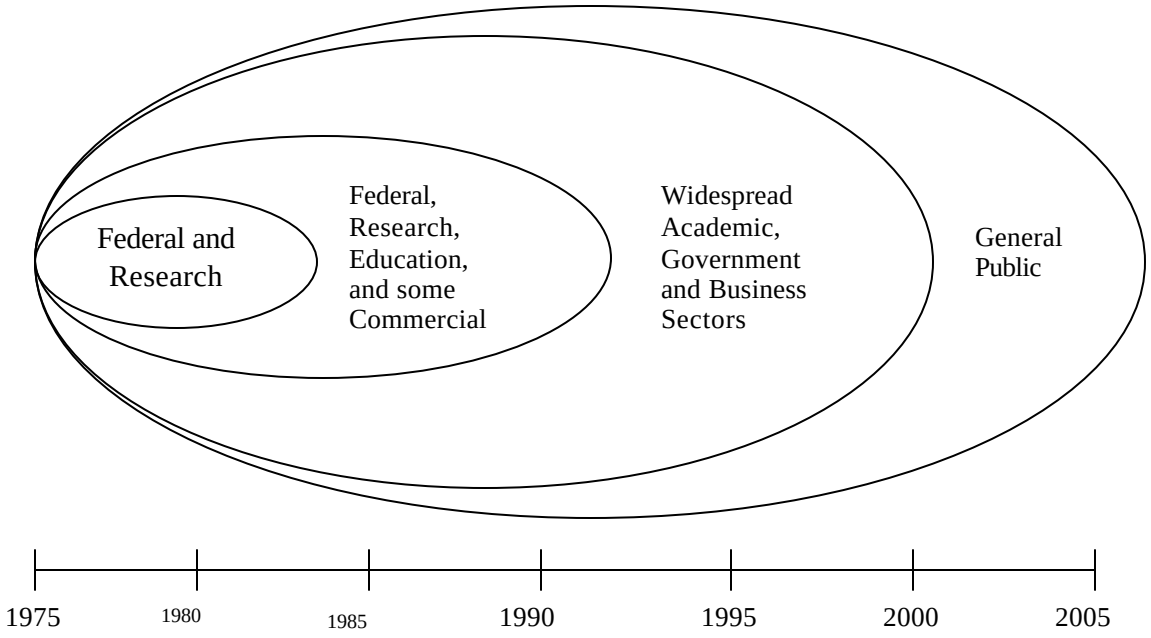
Expansion of Networking

The evolution of networking to various user domains is illustrated in Figure 3. Networking started with the construction of ARPANET between federal and university research labs in the early seventies. A few large companies also built their own private networks. For example, IBM built VNET which had 1,000 nodes in the eighties and was bigger than ARPANET.

Beginning in the mid-eighties, networking expanded beyond the research labs to education. It was first expanded to computer science and engineering programs, and later through the introduction of BITNET to business, medicine and other professional schools, and some commercial users. The nineties saw the widespread expansion to commercial users. By then, most major corporations had their own internal networks, which were simply hooked up to the Internet. For example, Sun Microsystems has 12,500 users on its network and does a million electronic mail transmissions a day (McNealy, 1994).

The connection of these extant corporate networks is one of the reasons why the commercial domain showed such dramatic increase during the nineties (Figure 2). By the year 2,000 expansion will be greatest among the general public, but growth will continue in the others sectors as well, particularly education and commerce.

Figure 3. The Expansion of Networking



NATIONAL INFORMATION INFRASTRUCTURE

Definition of NII

While the Internet is a forerunner of the NII and evolving to be a major part of it, the NII is conceived to be much broader as illustrated by various definitions. The first is that the NII is "a seamless web of communications networks, computers, databases, and consumer electronics that will put vast amounts of information at users' fingertips" (Information Infrastructure Task Force, 1993). This definition is consistent with the convergence of technologies and the creation of information utilities described earlier.

A second definition is that the NII "will integrate four elements—*communications networks*, *computers*, *information* and *people*—to create a whole new way of learning, working and interacting with others." What is different in this definition is the notion that the NII will *create whole new ways of doing things*. The NII is expected to transform society.

A third definition, which is from the Presidents' Council on Competitiveness, is the most interesting and bold in its predictions. It says:

> The information infrastructure of the 21st century will enable all Americans to access information and communicate with each other easily, reliably, securely and cost effectively in any medium—voice, data, video—anytime, anywhere. This capability will

> enhance the productivity of work and lead to dramatic improvements in social services, education and entertainment (Council on Competitiveness, 1993).

Aside from the boldness of this statement, it projects widespread use not only within business and education, but also within the household. Citizen use is seen as the domain where the NII will penetrate most broadly and deeply. It is unclear whether this will be the case, but time will tell.

Current Services on the NII

Although the various networks and technologies are a critical part of the NII, the key driver of its expansion and growth will be the services available to business, government, education, and household users. Many of the services that will be on the NII are already in place and have been for 50-100 years. Thus, their penetration is already extensive as illustrated in Figure 4. Voice communication via the telephone was invented in the last century and deployed in most developed countries by 1910-1930. Today, every country has a reasonable telephone system that is ubiquitous and accessible. Many have enhanced features such as voice mail and conferencing. Beyond regular communication, there is entertainment via television and cable whose penetration equals that of voice communication. Entertainment is important because it is the primary vehicle for promoting greater information services into the home, and because there is a very large industry built up around providing content in the form of movies, TV programming, news, home shopping and education. Text data access via computer networks is the most recent service into the home, and is growing rapidly as shown by the Internet figures earlier.

Figure 4. Penetration of Current Services

The U.S. has a population of 240 million people and about 160 million households. They are currently provided with various information services as illustrated below:

Local and long distance voice via 2-way and multiparty communication

94% have telephones.
20 million Americans, mostly business people, use cellular phones.
11 million Americans use 900 numbers each month, 50% of which are for erotica.
2% of the U.S. workforce telecommutes, working at home several days a week.

Entertainment via television and cable

98% of U.S. households have TV.
85% have a videocassette recorder.
65% are connected to cable TV.

Text data access via computer networks

30 million households (20%) have a personal computer.

5 million households are connected to online computer services such as CompuServe, Prodigy or Online America.

20 million people (business & household) use the Internet, growing at 40,000 monthly.

6000 bulletin boards exist on the Internet where people can exchange information.

Future Services

It is the expansion, enhancement and integration of these existing services, and the conduits to provide the services better, faster and cheaper, that is at the heart of the NII. Although there will be new services on the NII, initially most of the services will be improvements on what already exists. Local and long distance communications will be faster, more portable and have wider bandwidth. TV and cable programming will be more varied, available on-demand, and more tailored to specialty interests. Electronic mail will reach around the world and follow you around the world as voice mail is already beginning to do. Data access and exchange will be multimedia and will be assisted by intelligent software "agents" which learn individuals' interests and search the Internet and databases for the information needle in the data haystack.

There will be entirely new services as well. Plugged-in consumers will subscribe to electronic magazines and automatically receive color printouts of articles on favorite topics. New entertainment will be available in the form of video games, interactive video, and virtual reality. Sensors will take your temperature, blood pressure, and do a variety of tests, all with your doctor watching closely and discussing the exam as if you were in his or her office. Power companies will plug into a communications controller or an intelligent set-top device in the home and take meter readings long-distance, or even control big appliances like home freezers and air conditioners at times of peak electrical demand. The home network will help advertisers learn what interests consumers and will allow them to get material into consumers' hands immediately. For example, Hewlett-Packard is developing intelligent household printers designed to plug into the same network as PCs and TVs. With the click of a computer mouse or a remote control, users would be able to print out anything that appears on any screen in the house. A TV viewer could request information about a product and receive a catalogue at once. Which of these or other new services will become the "killer applications" of the future is unknown, which is why the current players in the NII are jockeying for position and for control.

As suggested by the nature of both current and future services, the markets for NII services are greatest in business, and only secondarily in the home. The services are going to show up first in organizations, especially those with large, dispersed workgroups which have a real need for the services (McNealy, 1994). This is important to recognize because much of the promotion

about the NII focuses on services to the home, as was the case earlier with promotion about home computers. When home computers were first produced in the early eighties, it was felt that the household market would take off, but it never did. Empirical studies of computing in the home show that computer use at home is primarily an extension of work at the office, and secondarily an extension of work at school (Venkatesh and Vitalari, 1993). The notion that home computing would develop its own place in the market has not materialized (although it may yet someday). Instead, computing continues to come into the home incrementally through work and school and through individual smart appliances rather than through some computer-based nerve center controlling all appliances, systems and communications. Given this business and organizational focus of the NII, the greatest markets will also be in large, urban areas rather than in small cities or rural areas. This is because urban areas are where the businesses and other organizational users are located.

The Players in the NII

The major players in the NII are *providers*, *users*, and *regulators* including national governments as users and regulators (Figure 5). National governments are near the bottom of the list in Figure 5 to signify that the NII is not being built or led primarily by government. The NII is a private initiative being led and built by the various providers. Government is a relatively small player, but as seen below, an important one in its promotional and regulatory roles.

Figure 5. Players in the NII

Providers
- Conduit
  - Long distance telephone companies (AT&T, MCI, Sprint)
  - Local telephone companies (RBOCs, GTE)
  - Cable companies (TCI, Cox Cable, Comcast Corp., Continental Cablevision Inc.)
  - Cellular phone companies (McGaw, Bell Atlantic)
  - Satellite communications companies (COMSAT, Hughes)
- Information devices
  - Computer hardware companies (IBM, Apple, DEC, Hewlett-Packard, Compaq, Silicon Graphics)
  - Software companies (Microsoft, IBM, Apple)
  - TV and electronics companies (RCA, Sony, Panasonic, Samsung)
- Content
  - Broadcast television and radio (NBC, CBS, ABC)
  - Cable companies (CNN, TCI)
  - Movie studios (Disney, Universal, Sony)
  - Publishers—newspapers, books, magazines
  - Online data services—credit (TRW), legal (Mead Data), brokerage (Quotron), exchange, commodities (Reuters), general (Prodigy, CompuServe, Online America)

Users
- Corporations
- Federal, state and local governments
- Education institutions
- Households and individuals

Regulators
- Federal Communications Commission
- Department of Commerce
  - National Telecommunications and Information Administration (NTIA)
  - National Institute of Standards and Technology (NIST)
- State Public Utilities Commissions

The various providers of the NII are currently engaged in fierce competitive struggles for control over the future information highways. These include the (1) *owners of the conduit* (telephone,

cable, cellular, satellite, broadcast TV), (2) *makers of information appliances* (TVs, telephones, computers and new integrated products), and (3) *providers of content* (movie studios, television programmers, information services, publishers, education).

The intense competition stems from the fact that the NII is in a state of transition from the current networks and services to future ones. None of the providers know what media or services will be successful in the market. Consequently, each provider is trying to shape future visions of the NII in their own interest while also ensuring they have a role in the current transition so they can learn how the NII is evolving and will be in a position to be a player in the future.[2] For example, AT&T would like to see the information infrastructure provided much like a utility with a single high-bandwidth cable coming to a central box outside each office or home as telephone and utility services currently do. Computer companies like Intel and Microsoft see the cable coming into a general purpose computer which would in turn distribute the signals to the TV, stereo, telephone, fax, household monitors, and other enduser devices (*International Hearld Tribune*, August 1994; *USA Today*, August 1994; *Fortune*, August 22, 1994; Piller, 1994).

The owners of the conduit are trying to position themselves for end to end communication. The long distance telephone companies—AT&T, MCI and Sprint—are trying to get into cable operations so they have a pipeline to homes and businesses—something they currently are prevented from doing on their own by government regulation. The local telephone companies—the Regional Bell Operating Companies and the independents—are trying to get into the cellular business so they can provide long distance services and are also forming alliances with entertainment companies so they have content to deliver over the networks. At the same time, they are working on compression technologies which will allow them to transmit high speed data and video over existing twisted pair copper wires to the home, enabling new services, such as video on demand, to be available through the existing local telephone network. The cable companies are working with computer hardware and software companies to develop set-top boxes for TVs that will allow multimedia services to be delivered to the home. They also are working on voice over coaxial cable technology that will allow them to offer telephone service to their subscribers. Thus, the various providers are attempting mergers, buyouts, alliances and technological solutions that preserve and enhance their options on an unprecedented scale. It is expected to result in reorganization of the entire industry and it is unclear who will be winners and losers (*International Hearld Tribune*, August 1994; *USA Today*, August 1994; *Fortune*, August 22, 1994; Piller, 1994).

The owners of content for the NII are also engaged in jockeying for position, but not to the same extent or in the same way as the owners of the conduit. All want to see NII built and

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[2]This is also happening among providers of information services. For example, DHL recently joined with IBM to bid for the development of Tradelink in Hong Kong because it is in the document interchange business and wants to be a player in the world of Electronic Document Interchange (EDI). Through this project, DHL hopes to learn what EDI means for its current business, to position itself for a role in EDI, and to find new business opportunities that exist because of EDI.

used. All want free access, or low priced access, to the information conduits. All want their intellectual property protected as it travels through the conduits.

What is most significant about the shakeout in the near term is that *it is not so much about creating new markets as it is about transferring revenue from existing ones*. The providers of NII hope to raid other industries' markets. The NII creates the possibility that services which are now delivered through separate conduits will be delivered in the future through a single interactive multimedia conduit. The industry providers are betting that users will chose this delivery channel over existing noninteractive and fragmented ones. If this occurs the revenue transfers could be large. For example, the cable TV market is $20 billion annually. The video-rental market is $12 billion strong. Catalogue shopping is $55 billion annually. Video gaming is another $15 billion annually. The consumer online data services are about $1 billion annually. Thus, the total potential of current home users—about $103 billion—already exceeds the total revenues of all the regional phone companies in the U.S.—about $82 billion (*Fortune*, August 22, 1994). Online information services constitute another $9 billion market to business and government. It is precisely because the stakes are so high for so many players that there is a role for national governments. National governments play a special role in the competition by setting the rule of the game (i.e., regulation of the industry and the radio spectrum), and by facilitating the evolution of the NII through research, standard-setting, promotion, demonstrations, and its own uses.

The Clinton Administration's NII Agenda[3]

National government roles vary considerably with respect to information infrastructure. For example, the Singapore government is provider, regulator or promoter. In contrast, the fundamental principle of the Clinton Administration's NII agenda is that the private sector, not the government, will lead the deployment of the NII. The government's role is circumscribed to seven key areas (IITF, 1993):

1. *Promote private sector investment.* The government, through the FCC (Federal Communications Commission), is liberalizing the telecommunications industry as a spur to competition and investment among telephone, cable, cellular, satellite and other providers.

2. *Extend the "universal service" concept to ensure information resources are available to all at affordable prices.* The government, through the NITA (National Information and Telecommunications Administration), is defining the concept of

[3]The NII is mainly the interest of Vice President Albert Gore, Jr., but President Clinton endorses it fully. Gore's interest is long standing. He reportedly coined the term information superhighway ten years ago while a Senator from Tennessee. His interest stems from the earlier work of his father, Senator Albert Gore, who authored the legislation for the U.S. interstate highway system--another major infrastructure. Vice President Gore saw the potential of information technology to play the same kind of role in uniting the nation, stimulating economic growth at home and increasing competitiveness globally. Since becoming Vice President, he has worked unceasingly to promote the NII to all segments of government, business and society.

universal service in the context of the new communication modes and information services.

3. *Act as a catalyst to promote technological innovation and new applications.* The government, through the NIST (National Institute of Standards and Technology), is sponsoring research into technological issues such as standards for interoperability and security. It is also supporting demonstrations of new applications such as digital libraries, electronic commerce, medical diagnosis, medical record sharing and distance education.

4. *Establish standards to remote seamless, interactive, user-driven operation of the NII.* Because the NII will be a network of networks, information must be easily transferable over disparate networks. The government is insisting that all network providers adhere to standards that provide for interoperability, interactive uses and ease of connection between networks. It is also reforming regulations and policies that inadvertently deter development of applications.

5. *Protect intellectual property rights and privacy.* Development of the NII provides new market opportunities for software products and information services. However, those opportunities will be realized only if government provides intellectual property protection of the creators of new software, information products and services. Also, getting broad use of the NII requires protection of individual and organizational privacy. People simply will not use the NII if their communications and data are not protected from unwarranted intrusion by government, industry, or individuals. While governments in particular have a need to know that sometimes must override the right of privacy, widespread use of the NII will not occur unless the balance is tipped in favor of individuals and organizations.

6. *Provide electronic access to government information and services.* The government is developing its own applications for the NII including the provision of broad access to executive and legislative documents, the provision of information about government programs, the receipt and processing of applications for services or funding under various programs, the electronic transfer of funds and payments, and the processing of income tax and other payments.

7. *Improve management of the radio frequency spectrum.* The ability to access the resources of the NII will be constrained if there is inadequate spectrum available. Therefore, the government will distribute spectrum by relying upon market principles, will promote public and private sharing of spectrum, and will increase choices for use of the spectrum by licensees.

In short, the Clinton Administration's role in the NII is limited to that of regulator and promoter, including promotion through its own demonstrations and use of the technology. Despite this limited role, the Administration plans to spend $1-2 billion annually in promotion and use (IITF, 1993).

Users and the NII

Despite the rhetoric of industry providers and the Administration about the potential benefits of the NII for consumers, the fact is that the interests of household users tend to be given relatively little consideration by the providers of NII. Users need technology that is easy to learn and use, but the new multimedia technology is complex and difficult to use. Organizations with technical staffs to provide assistance are having difficulty applying the technology to useful tasks and teaching their workers how to use it. Home users with technical experience are finding that their multimedia workstations take far more time, money and tending than their personal computers ever did. Users also want only the information they need, but instead are overloaded with more information than they could possibly use. The real issue is not to provide users with less information, but to make it easy for them to get the right information. Learning how to find the right information and dealing with the technology's complexity can be greatly aided by bringing the NII into the classroom (at all levels) as a teaching tool and a means of building familiarity.

Users also want services that enhance their personal lives, but the industry tends to focus on services that expand, enhance or otherwise reinforce their own interests. A recent *MacWorld* survey (Piller, 1994) indicates that household users are primarily interested in voting, public opinion polls, town-hall meetings, and the capability to do electronic mail with political leaders and other citizens. They also want access to reference materials, databases, how-to programs, education courses, and information about government programs and services. Video on demand and electronic games are relatively low on their list. In contrast, the telephone, cable and other providers want to deliver interactive broadband communications that will support services like video on demand, video gaming, electronic gambling, electronic shopping, and electronic advertising.

Building such capabilities requires huge investments and substantial markets to recoup the costs. The providers hope to raid other industries to speed up market development, but it is unlikely that such raiding will result in massive shifts because users are already invested in the others. User shifts to a new technology involve not only upfront costs for equipment but also costs for operations, support and especially learning. Schools lack the resources to provide the learning needed and state and local governments lack the resources to provide information and services attractive to users. Therefore, it is unlikely that they will get them. Instead they will get what industry can provide and thinks it can make money on. While the national government could require industry to work with the public sector and user groups in providing what is needed, doing so runs the risk that industry will simply back away from building the information superhighways.

A Global Perspective

Worldwide communications is now routine even if not always easy. There already is a global information infrastructure; it just has to be named such. Telephone service is global. The Internet is now operating in 160 countries. Television programming even reaches into countries

that try to keep it out. American movies are seen all over the world, Japanese games are played all over the world and CNN is the world's news network.

Many nations are developing or implementing plans to deploy national information infrastructure. In the Asia-Pacific region, plans have been announced by Japan, Korea, Malaysia, Singapore and Taiwan (Dedrick, Kraemer and Choi, 1994; Dedrick, Kraemer and Jarman, 1994; Raman and Yap, 1994; Gurbaxani, et.al., 1990; King, et.al., 1992; Kraemer and Dedrick, 1994c). And Japan, Korea and Singapore are on their way to deployment. Some nations with skills in IT planning are now selling NII planning services to other countries. Singapore is a case in point, as is the U.S. Similarly, nations with skills in IT deployment are selling NII building services. France, Germany, Japan, Sweden and the U.S. are major competitors here and developing countries such as China, Indonesia and Malaysia and Thailand are major recipients of such services (Kraemer and Dedrick, 1994d).

Multinational corporations are moving ahead on NII whether governments do or not. Most multinational corporations already have their own private worldwide networks for data communications. The multinationals have had to build these networks because the production system is now global and requires it. Sourcing is from all over the world. Markets are all over the world. Manufacturing has to be close to markets and increasingly, so does design and R&D. One critical way of bringing them closer is communications, whether between the home manufacturing plant and foreign sales offices or between headquarters and foreign plants.

It is clear from the foregoing that the information superhighway is not simply a national infrastructure, but is a global one. And it is not something in the future, but something that is already here and growing rapidly. Individual countries must expect their NII to be part of the global information infrastructure. Indeed, as with many communications technologies, the greatest benefits will accrue when use is ubiquitous.

IMPLICATIONS OF THE NII FOR COMPETITIVENESS

From the beginning, the NII has been characterized as promoting the competitiveness of U.S. business and industry (Council on Competitiveness, 1993; USITC, 1993). Indeed, this is a stated reason by many nations as to why they are developing their information infrastructure (BPT, 1990; MPT, 1989; NCB, 1987).

The overall competitiveness advantage of the NII is that it creates a communication infrastructure which is expected to have economic effects similar to, but greater than, other infrastructures. It used to be that nations (and their industries and individual firms) were more or less successful in competition with other nations depending upon the kind of transportation infrastructure they had. Nations with deep water ports did better than nations unable to exploit the technology of ocean transportation. After World War II, nations with good highways were able to bring goods and services to market cheaper and faster than those without them. And nations with reliable, safe international air transport were able gain from the growth of tourism and global sourcing during the eighties and nineties over those without. In the future, commerce

will roll on information highways and airways. Consequently, nations that have low cost, reliable communications infrastructures will attract businesses and telecommunications traffic over those that do not, just as with the earlier infrastructures. The businesses add to the economic diversity and strength of a nation and the telecommunications traffic adds revenues that can reduce overall costs of the network and provide funds for modernization. Hong Kong and Singapore have become manufacturing locations and regional headquarters for many multinational corporations because of their telecommunications infrastructures among other factors.

As the foregoing discussion illustrates, the NII potentially has impacts on economic development and competitiveness in four ways:

1. *Support the activities of existing industries and enhance their competitiveness.* Better computer and communications technologies will enable all organizations to operate faster, more flexibly, more coordinated and less expensively, thereby enabling them to compete more successfully. It will enable a nations businesses to be at the forefront in exploiting new opportunities created by the technology whether these enable shifts in market share, focus on niche markets, or entirely new products, services and markets.

2. *Attract new multinationals to locate in a country, and encourage existing multinationals to expand.* Advanced communications and computer technologies such as those proposed for the NII, allow businesses to locate manufacturing, engineering and sales closer to markets and still coordinate these distributed and far flung activities with headquarters and regional locations around the world.

3. *Increase communications traffic over the nation's network thereby enabling cost reductions and/or reinvestment in advanced facilities and services.* An advanced infrastructure can attract in-transit communications activity and stimulate greater use of telecommunications through advanced services such as electronic mail, teleconferencing, EDI, packet switching and data communications.

4. *Develop information industries that can create information products and services for export.* It is likely that firms within nations that lead in deployment of NII will be first to create the new information products and services used domestically that can be exported to the rest of the world. The providers of information services and the makers of information appliances will have growing opportunity for export. France has become a substantial exporter of information services through its Minitel System. Minitel services are now available in multiple languages in at least 14 other nations, and international access time to the Minitel System now runs several hundred thousand hours per year (Davidson, et.al., 1993).

It is important to recognize that the competitiveness issue is not simply one of being left out of the communications infrastructure, because all nations will be connected sooner or later. The issue also is not simply one of being first with the NII, because first mover advantage often brings tremendous upfront costs, long paybacks and high risk. *Rather, the competitiveness*

issue is whether a nation moves fast enough to be part of the critical mass of other movers so that one is not left behind. All communications technologies require diffusion to a critical mass in order to gain the benefits of use, and so the issue is to be part of the mainstream rather than too far ahead or behind. An important role of government is to stimulate the critical mass of users as the NII is implemented.

A related competitiveness issue is that all nations must undergo institutional and social learning in order to use the new technologies. Although one could outsource the technical provision of a nation's information infrastructure (as is now being done with telecommunications in China), the NII is not something a nation can simply plug into—even though such images often appear in the popular press. A nation must learn how to build and maintain the NII, and develop applications on it. A nation must develop the institutional structures required to coordinate its deployment, governance, regulation, and use. And it must develop the awareness and skills of its population for effective use. Such learning cannot occur overnight. Singapore, which is faster in its development than any other nation will probably do it over a period of twenty years partly because it is small, has a unified government, and is highly focused on the NII as part of its self-image as a nation. For example, every household with a computer will be connected to the Internet by the year 2000 (*Asia Computer Week*, 1994). The speed and ease with which such learning occurs affects the competitiveness of a nation's businesses and people.

A final competitiveness issue relates to effects on the freedom of nations to operate inefficiently and outside international business norms and standards. As commerce is increasingly conducted electronically, it will not be possible for nations to hold to their own unique institutions, norms and standards without paying a price. For example, if a nation's coordination mechanisms for the NII are bureaucratic, cumbersome and slow, it might loose out to a nation with focused institutions that can move fast in response to market opportunities. Similarly, if a nation chooses to flaunt intellectual property protection laws in the name of furthering its own businesses, it will have to deal with the business culture it has created when it wishes to enforce such laws to aid its own software, entertainment or publishing industries. Also, protection of domestic producers through import duties will be less feasible because of GATT agreements and gray markets. Protection of the local market through unique domestic standards will be self-defeating because of the requirement to follow international protocols in order to participate in global communications. Similarly, protection through quotas on imports of information services will be infeasible. All such measures simply increase costs to the economy as a whole.

SUMMARY AND CONCLUSIONS

In summary, there are seven major points that derive from the NII experience in the U.S.:

1. *The NII is already here.*

It is not some futuristic electronic highway that is yet to come. It is here in the telephone, cable and computer networks that already exist. Its potential is illustrated by the Internet.

2. *The extension and integration of existing facilities and services is at the heart of the NII.*

Although there will be new facilities and services downstream, the near term development of the NII will focus on extension of existing voice, video and data facilities and services through existing networks. The services will be more varied and the networks will be more integrated, but services will be provided mainly through upgraded and expanded telephone, cable, broadcast, cellular and satellite facilities for communication.

3. *The NII services that will have the greatest demand are those that are already here.*

These include telephone, voice mail, electronic mail, file transfers, teleconferencing, electronic document interchange, online data services, and data communications. Services such as video on demand, video gaming, electronic gambling, remote shopping and electronic banking will be slower to develop and will require a long time for payback. Many will payback only after failed ventures are taken over by new owners at a fraction of their costs to build.

4. *The market for NII services is greatest in business and government, and secondary in education and the home.*

When home computers were first produced in the early eighties it was felt that the household market would take off, but it never did. Empirical studies of computing in the home show that computer use is primarily an extension of work at the office, and very secondarily an extension of work at school. The notion that home computing would develop its own place in the market has not yet materialized although it may someday. Instead, computing continues to come into the home incrementally through work and school and through individual smart appliances rather than through some computer-based nerve center controlling all appliances, systems and communications. Government can stimulate greater application by using the NII as a teaching tool in the classroom, building familiarity with it, and providing government services and information.

5. *The building of the NII is basically a private sector affair.*

Investment in the NII will be mainly a private affair as will the expansion of existing infrastructure, the provision of new communication modes and the provision of products and services. Private investment over the next 20-30 years will be ten times that of government.

6. *Government plays a key role and will continue to do so, but leadership in the NII is more than simply a governmental concern.*

Coordination among the various players in the NII is the key leadership issue. In contrast to other nations with a single central coordinator, in the U.S. coordination will be shared between government and private institutions such as industry associations, business leaders, professional associations, and user groups. As a consequence, deployment might be slower but innovation might be higher.

7. *The primary goal of government involvement in the NII is to increase the competitiveness of business and industry in the global marketplace.*

   It is expected that competitiveness will result from creating a critical mass for use of the NII that enhances industry leadership, supporting institutional and social learning that facilitates use of existing and future services, creating new opportunities for existing and emerging information industries, increasing the efficiency and effectiveness of government, business and the whole economy, and setting the standards and norms for the global NII in concert with other nations, recognizing their likely impacts for competitive advantage.

Finally, it is important to realize that many current predictions about the NII will be proven incorrect. A recent issue of *The Economist* carried an article entitled "Does it matter where you are?" It points out that a cliché of the information age is that telecommunications and networks decrease the importance of time and space. As a result, companies no longer need big central headquarters; the headquarters can be decentralized; they can be located anywhere; they can even be moved around. Firms no longer need offices; employees can work at home, at their client's home or office, or in their cars. There is something to this viewpoint. Programmers in Bangalore, India log on to Texas Instrument computers when programmers in Austin, Texas go home. Foreign exchange markets run 24 hours a day. At least one California company has no offices; all employees have a portable computer and CompuServe account and meet when needed anywhere that is convenient. The implication of this trend is that there will be greater and greater dispersion of people and economic activity.

However, this prediction flies in the face of history and other important trends. Tokyo has been trying to decentralize for 25 years and it is not working despite the national and city government's considerable efforts. Yet, computing and communications capability in Tokyo and Japan has increased 20-30 times during this period. Despite the fact that they can be distributed, people and economic activity continue to be more concentrated than dispersed—although some may shift from California to Salt Lake City, Utah or to Penang, Malaysia because of cost differences. The reason for concentration is that history counts. People and economic activity are where they are because of where they have been in the past. Manufacturers and their suppliers co-locate to reduce coordination costs and to facilitate innovation. The new computer and communications technologies will overcome some of this, but not most as is illustrated by a main effect of the Internet. The most advanced use of the Internet has not been to find a global village, but to strengthen business and social ties of firms and people in Silicon Valley, California.

The point is that technology often supplements and reinforces existing arrangements rather than supplants them. While this is true of all technologies, it is especially true of communications technologies because it is a well-known finding from communications research that new communication modes compliment older ones, rather than simply replace them. Moreover, communication generates still other communication. As the communication becomes more intense, so does the need for/desire for face-to-face communication which is what helps to produce concentration. This example also illustrates the fundamental fact that we are not very

good at predicting what will be reinforced and what will be supplanted. That is why the future being created by national and global information infrastructure is going to be very interesting—for the providers, regulators and all of us as users.

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